FROM THE TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA
THIRD SERIES—1907-1908
VOLUME 1

President's Address, Agricultural Progress

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OTTAWA
PRINTED FOR THE AUTHOR BY THE ROYAL SOCIETY OF CANADA
1908

APPENDIX A

AGRICULTURAL PROGRESS

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PRESIDENT'S ADDRESS

AGRICULTURAL PROGRESS.

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The organization of the Royal Society of Canada in 1882, was the means of bringing together the scattered workers in science and literature residing in different parts of the Dominion, and within its limited membership were included representatives of most branches of knowledge. In choosing the member to be raised for the time being to the dignity of presiding officer of this Society, care is taken that during the course of years the different branches of science and literature shall be thus honoured through their representatives. It has been the custom for the member elected to the Presidency to devote the main portion of his address to the presentation before the members, of some of the more important and interesting features of the work in which he is engaged.

Permit me then to call your attention to some facts in connection with the development and progress of agriculture in general, also to the great agricultural progress which has taken place in Canada during the past twenty years and to the glorious outlook for the future.

Every reader of the Old Testament is familiar with the references to Egypt as a land rich in corn, one that produced sufficient for its own population and a surplus also for export to neighbouring countries. The patriarch Jacob, during the time of great famine, sent his ten sons to buy corn in Egypt saying "Behold I have heard that there is corn in Egypt, get you down thither and buy for us from thence, that we may live and not die." Profane history bears testimony to the skill of the farmers of ancient Egypt, and this skill was exercised under favourable conditions. The soil was naturally fertile and was still further enriched by the annual overflow of the Nile.

The nomads of the patriarchal ages while mainly depending for sustenance on their flocks and herds, also engaged, in some instances, extensively in the tilling of the soil. Isaac combined tillage with pastoral occupations for we read that he sowed in the land of Gerar and reaped a hundred fold. Job also is represented as having, besides immense possessions in flocks and herds, 500 yoke of oxen which he employed in ploughing and in a very great husbandry. The Israelites were one of the great agricultural nations of antiquity, much the larger proportion of them being occupied in that pursuit. Their principal crops were wheat, barley, spelt, millet, beans and lentils. They also had vineyards and groves of olive and fig trees. Theirs was a land of corn and wine, a land of bread and vineyards, of olive oil, milk and honey.

Amongst the ancient Romans agriculture was highly esteemed, and pursued with earnest love, and devoted attention. They were a thoroughly agricultural people, and it was only at a later period that trade and arts were introduced among them and even then agriculture occupied by far the most prominent place. Their love of agricultural pursuits survived for a very long period, and when at length their boundless conquests brought unheard of luxury and with it the corruption of their morals, the noblest minds among them were strongly attracted towards the purer and simpler life of the ancient agricultural times.

The words which Cicero puts into the mouth of Cato give a fine picture of the enthusiasm of the Romans in agriculture "I come now," he says, "to the pleasures of husbandry in which I vastly delight. They are not interrupted by old age, and they seem to me to be pursuits in which a wise man's life would be well spent. The earth does not rebel against authority, but gives back with usury what it receives. I am charmed with the nature and productive virtues of the soil. Can those old men be called unhappy who delight in the cultivation of the soil? In my opinion there can be no happier life, not only because the tillage of the earth is salutary to all, but from the pleasure it yields. Nothing can be more profitable, nothing can be more beautiful than a well cultivated farm." In the later ages of the Empire, agriculture was neglected, and those engaged in it were regarded with disdain, the supplies of food for overgrown Rome being drawn mainly from Egypt, Sicily and other provinces.

Under the Goths, Vandals and other barbarian conquerors, agriculture in Europe during the middle ages seems to have sunk into the lowest condition of neglect and contempt. During the greater part of this long period, the population of Europe was divided into two great classes. By far the larger one was composed of bondmen, without property or the means of acquiring it; the other class consisted chiefly of the great Barons who owned large areas of land, and who also owned their retainers who were the tillers of the soil. It was the ignorant bondmen on whom rested the burden of the cultivation of their master's land. The retainers, however, were more frequently employed in laying waste the fields of their master's rivals than in cultivating their own. Subsequently the practice began to prevail of renting portions of the land to the peasant who paid his rent in grain or cattle. Under this arrangement the land began to be more carefully cultivated, and to yield greater profits to the owners.

Wheat was the most valuable grain grown, but must have borne but a small proportion to other grain crops. The extravagant prices at which wheat was sometimes sold, give evidence that its consumption was probably confined to the wealthy. Rye, barley and oats furnished the food of the great body of the people in Europe.

There was not as much variety in the food of the people then, as there is now. The potato was introduced into Britain from America in 1586 and grown that year on the estate of Sir Walter Raleigh in Ireland, near Cork, but this valuable tuber came very slowly into use. In 1663, seventy years later, the more general growth of the potato as food for the people was strongly urged by the Royal Society of London. But even that important endorsement did not bring it rapidly into favour, and not much more than a century has elapsed since its cultivation on a large scale has been general. It was not until the reign of Henry VIII that carrots and other edible roots and plants began to be cultivated in England. Prior to this the small quantities of vegetables used, were imported from Holland and Flanders. Hume in his History of England, speaking of this period, says that Queen Catharine when she wanted a salad was obliged to dispatch a messenger to Holland to secure the necessary material.

Early in the 16th century, following the invention of printing and the revival of learning, agriculture partook of the general awakening and during the course of this century, several important treatises on the subject appeared, written by men who engaged eagerly in this neglected and hitherto despised occupation. The information thus given did not, however, produce a rapid change. Up to the middle of the 17th century it is said to have been a common practice, to sow successive crops of grain on the same land until it was utterly exhausted, and then to leave it foul with weeds to recover some measure of its fertility by an indefinite period of rest.

During the latter part of the same century the rotation of crops began to be practised under the name of alternate husbandry, and before the end of that century, great improvement had taken place, not only in the methods adopted for the growing of crops, but also in the quality and breeding of cattle and sheep. The value to subsequent crops of the ploughing under of clover to enrich the soil was also known and more or less practised at this early period.

One of the great burdens which rested on agriculture in early times in Great Britain was the levying of Purveyance. What was called the larger Purveyance involved the obligation on the nearest farmers to furnish at the current prices, provisions, carriages, etc., in time of war to the King's armies, houses and castles. The smaller Purveyance included the furnishing of the necessary provisions for the household of the King when travelling through his dominions. These the tenants on farms belonging to the Crown were obliged to furnish gratis, and this practice came to be adopted by the barons and great men of the Kingdom, in every tour which they thought proper to make in the country. These exactions were so grievous and were levied in so high handed a manner, that the farmers when they heard of the approach of the Court, often deserted their houses and hid their supplies, just as if the country were being invaded by an enemy.

Purveyance is said to have been for several centuries one of the chief obstacles to agricultural advancement in Great Britain, and the practice continued down to so late a period as the reign of James the First.

The increase in the population of Great Britain was an important factor in stimulating improvements in agriculture, for the more people there were to be fed, the greater the need of enlarging the area under cultivation and of adopting the best methods known in order to produce the largest crops.

Prior to the taking of the first census in England and Scotland, which was in 1801, the method of computing the population was by the number of baptisms, which were carefully registered. The total number of baptisms was made up every ten years, and these were multiplied by 33, which was regarded as the average number of years in a human life. The number of deaths was also computed, and in so far as the baptisms exceeded the burials in number a corresponding increase in the population was shown.

Under this method of calculation the population of England and Scotland combined amounted in 1710 to 6,015,193. In 1740 it had risen to about 7 millions; in 1780 to 9¼ millions and in 1801, when the first regular census was taken, it was found to be 10,785,840.

From 1801 to 1811 the increase was still more rapid, the census of 1811 showing a population of over 12½ millions, which was more than double the number at which it was estimated in 1700. The population of Ireland is not included in these figures since there was no attempt to take a census of the people there until 1811 and then it was very unsuccessful.

On taking a general review of the production of grain in Great Britain and of the growth of the population there for the period of 119 years from 1697 to 1815 inclusive, the account stands thus:

In the first 70 years, from 1697 to 1767, the population increased one-third, growing from six millions to over eight millions, and during that period there were exported over and above the quantity imported 272 million bushels of grain. In the remaining 44 years, from 1767 to 1811, during which the population rose from 8 millions to over 12 millions, an increase more rapid than British agriculture could quite keep up with, the total excess of imports over exports of grain was about 132 million bushels in all, equal to about 2,800,000 bushels of grain annually. During the last five years of the period referred to, from 1811 to 1815, notwithstanding further increase in the population, and the waste and expense of wars, Great Britain, favoured with good harvests, was able to raise a sufficient food supply to sustain her own people.

It is interesting to think of that fertile little island feeding all her own population and having a balance for export up to about 150 years ago. Notwithstanding the rapid increase in the number of food consumers during the next 49 years (up to 1815) she was able to occupy about the same independent position. How different things are now with a population of about 44 millions and an annual demand over and above all home production of over 200 million bushels of wheat.

The growing of regular crops of cereals and other food products is rendered possible by the large stores of plant food laid up in the arable soils which cover a large part of the earth's surface. Of the constituents which enter into the composition of these soils, quite a number are taken up by living plants, in varying proportions; but, of many of these, the quantities used are small and the store of such contained in the soil is usually ample. There are, however, three ingredients, nitrogen, potash and phosphoric acid, which plants take from the land on which they grow, in considerable proportion. The presence of these important constituents in sufficient quantity, and in available form, determines in large measure under reasonably favourable climatic conditions, the character and weight of the crop.

It is estimated that an acre of soil, a foot deep weighs on an average about 3,500,000 lb. and the results of many analyses of good ordinary loam in Europe, where the soil has been long under cultivation, show that it contains in most instances not less than 3,500 lb. of nitrogen per acre, and sometimes more. The quantity of potash varies from 5,000 to 8,000 lb. and the phosphoric acid from 3,000 to 6,000 lb. In all fertile soils we find these elements, in considerable proportions, associated with smaller quantities of others, such as lime, magnesia, silica, etc., together with large quantities of humus, the latter the result chiefly of the decomposition of vegetable matter. These are all necessary to the production of healthy plant growth.

An average crop of wheat will take from the soil for the grain and straw about 41 lb. of nitrogen, 20 lb. of potash and 18 lb. of phosphoric acid. A crop of oats will take a little more nitrogen, considerably more potash and less phosphoric acid. These may serve as examples but every successive crop tends to deplete the remaining store of these important elements and although the yearly reduction in quantity may be small compared with the total content, yet unless some means of restoration be provided, the richest soil eventually becomes poor.

In a series of seven analyses of soils from the Northwest Provinces, made by Mr. Frank T. Shutt, Chemist of the Dominion Experimental Farms, they were found to contain an average of 18,000 lb. of nitrogen, 15,580 lb. of potash and 6,700 lb. of phosphoric acid per acre, showing that the soils in the Canadian Northwest are much richer in these important elements of plant food than good average soils in Europe.

While nature at times seems lavish and, in some respects, almost prodigal, she is at the same time strictly economical. A substance may undergo a change in its character and thus elude our grasp, but nothing is ever lost. Decomposing masses of organic material undergo rapid changes in the laboratory of nature. Thus the nitrogenous matter they contain is converted largely into ammonia and nitric acid, which being volatile are disseminated through the atmosphere and brought down again to the earth to serve the purposes of plant growth by succeeding showers of rain.

Experiments conducted at Rothamsted, England, and elsewhere, during the past few years, to determine the quantity of these nitrogenous compounds in the rainfall, have shown that about 3.84 lb. per acre are thus given annually to the soil during the growing season.

During the past winter, Mr. Frank T. Shutt, Chemist of the Dominion Experimental Farms has determined the nitrogen compounds in snow. From his results he estimates that in 90 inches, the average snowfall at Ottawa for the past sixteen years, there would be approximately 1 lb. of nitrogen in the form of ammonia and nitrates and nitrites on each acre.

The farmer who neglects his barn-yard manure and allows its valuable constituents to be partly dissipated by excessive fermentation, loses thus so much of his capital, but the atmosphere holds what has been wasted, and refreshing showers dissolve this gaseous material and bring it to earth again in the very best condition for assimilation by plants. Thus the careless farmer unwittingly becomes more or less a public benefactor, and while he loses a large part of the nitrogen taken from his soil, the material is partially restored to earth in the rainfall elsewhere.

Nature has also admirable provisions for restraining waste. In all arable soils the quantity of plant food which is soluble and immediately available is relatively small. Much the larger portion of the elements of fertility are stored in the soil in insoluble forms. Hence only a small proportion of the store laid up for the use of the husbandman can in any given period be wasted, no matter how ignorant the farmer may be or how unwise the treatment to which he subjects his land. The process by which such insoluble plant food is changed to soluble forms, is a gradual one, in which bacteria are said to play an important part. This process is also accelerated by frequent and thorough cultivation of the soil, so as to expose its particles to the action of the sun and air. Thus industry and energy on the part of the farmer bring their reward in increased supplies of available plant food, when, under favourable climatic conditions, increased crops are realized.

Recent investigators have found that when soils are exposed to the air and rain for considerable periods they show marked increases in the quantities of nitrogen they contain and that these additions of nitrogen have been brought about by minute living organisms in the soil, which have the power of taking nitrogen from the air and converting this into nitrogenous compounds which are retained in the land.

These nitrogen-fixing bacteria consist of a number of different species, varying in the degree of their activity according to the conditions of light, temperature, moisture and the porosity of the soil in which they are working. Soil bacteria and other lower organisms are also said to produce acids in the soil, which aid in dissolving and rendering assimilable other important elements of plant food.

Thus through the agency of soil bacteria some portion of the nitrogen lost through cropping is brought back directly to the soil. This will partially explain why land which has been impoverished by over-cropping does recover some portion of its fertility if it is allowed to remain long unused. Nitrogen is all about us. It constitutes about fourt-fifths of the ocean of air in which we live. The supply is inexhaustible and if means could be devised for readily producing soluble compounds containing this element at a low cost, the possibility of supplying this important ingredient to the soil in quantities sufficient to induce luxuriant vegetation would be permanently assured.

It has long been known that many farm crops are greatly improved by the ploughing under of a previous crop of clover. Within recent years it has been shown that this result is largely due to the fact that clovers in common with other leguminous plants have the power of taking nitrogen from the air, and that this is done through the agency of colonies of bacteria which inhabit small nodules or swellings on the roots of these legumes. Experiments conducted for a series of years at the

Central Experimental Farm have shown that a single crop of clover ploughed under improves subsequent crops for several years. In the tests made with oats the average increase in crop has been about ten bushels per acre of grain with a considerable increase in the weight of straw. Barley which followed the oats without any further ploughing under of clover, has given an increase in grain almost equal to that of the oats, with a lesser increase in straw, while a third crop on the same land has shown a decided, although reduced, increase.

Nitrogen is the most expensive constituent of artificial fertilisers, at the same time it is indispensable. It produces a strong and healthy growth of foliage, and helps to build up the so-called plant albuminoids, which are so nourishing to animal life. Nitrogen is now supplied to the soil artificially in the form of sulphate of ammonia and nitrate of soda, both soluble nitrogenous salts.

The sulphate of ammonia is a by-product formed in connection with the manufacture of illuminating gas. Formerly this was wasted, but now almost every large gas works has its sulphate of ammonia plant, and the total annual production of this salt is estimated at nearly 500,000 tons, more than one-half of which is used in the manufacture of fertilisers.

Nitrate of soda, however, is the principal source of the nitrogen provided in artificial fertilisers. This salt occurs in enormous deposits in the northern parts of Chili, principally in the Province of Tarapaca. It is found in layers varying in thickness from a few inches to ten or twelve feet, lying usually on a deposit of clay and gravel, near the surface and beneath a covering of sand and gypsum. The impure salt is dug out or blasted, and purified by dissolving in water and crystallising. The nitrate of soda industry has developed enormously in recent years. In 1884, the total output was 550,000 tons, in 1900 it was 1,490,000 tons. It is held by those who have carefully examined these deposits, that at the present rate of mining they will be exhausted within twenty-five years, in which case there will be a serious deficiency in nitrogen for fertilising unless a new source of supply should meanwhile be discovered.

With a nitrogen famine in prospect many attempts have been made to utilize directly the nitrogen in the air and bring it into such a state of combination as will make it available for agricultural purposes. The advantages which would result from the obtaining of nitrogen compounds at a reasonable cost from this inexhaustible source can scarcely be overestimated.

Some three or four years ago a new nitrogenous fertiliser was produced in Germany, known as calcium cyanamide, or lime nitrogen.

This was produced by the action of electricity on the air in presence of lime and carbon. This compound, which can, it is said, be cheaply made, contains about 20 per cent of nitrogen, and field experiments on crops in Europe during the past three years have shown satisfactory results from its use.

Priestly was the first to discover that when a mixture of nitrogen and oxygen is subjected to the action of electricity a combination is effected and a mixture of nitric and nitrous acids formed. In 1898, Sir William Crooks, in his annual address before the British Association, pointed out the great possibilities in atmospheric air as a source of nitrates for fertilizing the soil and showed that it was possible by the use of a powerful current of electricity to combine the nitrogen existing in the air with the ozygen also found in the air and thus to make nitric acid. In this way the means could be found to increase the productivity of the grain growing areas in the world, without which he maintained there was danger of a shortage in the supply of wheat in the future. He ventured to predict that electrical energy produced by water-falls would at no distant time, be utilised for the production of nitrogenous compounds suitable for plant food.

Attempts to realize this prediction have recently been made in several countries. An American company was formed with this object, which had at its disposal, at Niagara Falls, several thousand horse power. After spending about a million dollars, considerable quantities of nitric acid were made but it was found that the cost of manufacture was too great to permit of the company competing successfully with the present sources of supply. Hence the project has been abandoned.

A similar misfortune overtook a company which organised a plant with a similar object at Freiburg in Switzerland.

Quite recently, however, information has been received to the effect that Norway has solved the problem. A large plant has been established by a syndicate having at its disposal from several large water-falls, about 400,000 horse power. The works have been established at Notodden, near the falls of the Tenelf, which furnishes the necessary electrical energy. At this factory more than 33,000 lb. [illegible] pure nitric acid is made per day, directly from the air. From 10,00[illegible]0,000 horse power is said to be necessary to carry this work on successfully. The nitric acid is saturated with lime and the resulting calcium nitrate is used as a fertiliser. The particulars of the process are not yet fully known, but it is said that nitric acid can only be made at present at a price to stand the competition of the nitrates from Chili, where the power from the water-fall can be had for about three dollars per horse power per year.

In this way the ingenuity of man is providing in good season, a way of escape from the dire results of a nitrogen famine.

Potash, which as a plant food stands, perhaps, next in importance to nitrogen, is widely distributed in nature. Many clay soils contain this element in large proportion, in the form of silicate of potash. It is found in all fertile soils in considerable proportions, and when the quantity of this element in the soil has been depleted by over-cropping, it may be restored by the application of wood ashes or some other potash fertilizer. A good dressing of barn-yard manure, which also contains a considerable proportion of potash will help to restore a soil so impoverished.

Most of the potash salts found in commerce or used as fertilisers come chiefly from Germany where they exist in practically inexhaustible beds, underlying a large section of country. These beds are about a thousand feet under the surface and vary in thickness from 50 to 150 feet. The crude products vary in the percentage of potash they contain. Kainit, which is sent into commerce just as it comes from the mine, contains from 12 to 20 per cent of potash. The purer potash salts, such as muriate and sulphate, are made from the crude products of the mine by dissolving, filtering and crystallising. Some idea of the enormous demand for these potash salts may be formed from the fact that the works afford employment for over 9,000 miners and labourers. The annual output is said to be about 1,500,000 tons.

For the third important element, phosphoric acid, there are several sources of supply, and the quantities obtainable are large. The bones of animals which consist mainly of phosphate of lime was the first form in which a phosphatic fertiliser was used on crops. The bones were crushed or ground, and the finer they were made the more prompt and manifest was the good effect produced. Bone meal was first used about the beginning of the 19th century, when its value as a fertiliser for turnips was demonstrated. About 1840 superphosphate of lime, made by the treatment of bones with sulphuric acid was introduced. This compound was much more soluble and speedy in its action on crops.

Shortly afterwards mineral phosphates were discovered. They were found chiefly in America. In Canada there are large deposits, especially in Quebec and Ontario, where they occur in crystalline form. The mineral phosphate, or apatite, found in Canada contains a larger percentage of phosphoric acid than most of that found elsewhere and was mined quite extensively for many years, but more recently other deposits have been found where the material is more abundant and more cheaply worked and most of the Canadian mines have been closed. In South

Carolina, mineral phosphates are found in large quantities, and, in Florida, this substance is still more abundant. In Tennessee, also extensive deposits exist.

Another abundant source of phosphoric acid, is a by-product in the manufacture of steel. Much of the iron used for this purpose in England and Germany contains small quantities of phosphorus, which makes the metal brittle and unfit for many purposes. In the process of transforming the iron into steel, the metal is heated to a very high temperature when the phosphorus is volatilised and the vapour passed through lime, with which it combines, forming phosphate of lime. For many years the slag from the iron furnaces was thought to be of no value, but chemical analyses showed that it contained large quantities of phosphoric acid in available form. This slag is now ground to a fine powder and sold as a fertiliser under the name of "basic slag." The German iron works make about 400,000 tons of this phosphatic fertiliser every year, and large quantities are also made in England, Belgium and other countries.

From the facts submitted it seems evident that, as far as the three essential elements of plant food are concerned, it is highly probable that there will always be a sufficiency for the needs of mankind, and that the waste arising from the cropping of the land may be so far restored as to assure permanent fertility. The idea sometimes advanced, that the rapid increase in population will after a time out-grow the possibilities of the earth's production, seems to point to a very remote contingency. The facility with which large areas of the earth's surface could be stimulated to increased productiveness, added to the enormous areas of fertile land still in its virgin condition, should be sufficient to quiet any fears on that score for a very long time. We know that in some parts of Great Britain lands have been cultivated more or less continuously for upwards of a thousand years and yet are now probably producing as large crops as they ever did. This has been mainly accomplished by the feeding of stock with the crops grown on the land and applying the manure obtained to the soil. In this way, if the return is complete, about 90 per cent of the important elements of plant food taken by crops from the soil can be restored to the land. By supplementing the farm manure with occasional applications of artificial fertilisers, good crops may be indefinitely maintained.

The value of animal excreta as a fertilizer has been appreciated by the husbandman as far back as records go, but it was not until 1804 that much light was thrown on the value of the mineral constituents of plants, when De Saussure announced his discovery of the significance of the ash of plants and pointed out that in the absence of these mineral constituents plant life was impossible. He was also the first to show that the ash of the plant contains all the solid materials taken by the plant from the soil except the nitrogenous compounds.

Liebig, in his reports to the Britsh Association in 1840 and 1842, demonstrated the importance of having a sufficient supply of the essential elements of plant food in soluble condition in the soil so that plants may obtain from the land the ingredients necessary for their growth. By the middle of the 19th century, it was well understood that nitrogen, potash and phosphoric acid were the essential ingredients required, which, if not already existing in the soil in sufficient proportion, must be supplied or good crops could not be had.

The chief distinction between the functions of farm manure and commercial fertilisers may in a general way be thus stated. Farm manure increases crop production by supplying the elements needed in about the right proportion for healthy plant growth, and at the same time by the addition of humus improves the general condition of the soil, while the commercial fertilisers act directly as plant food, without materially affecting soil structure. It is evident, therefore, that commercial fertilisers are not an adequate substitute for farm manure for producing permanent improvement. On virgin soils they are generally superfluous, but, as loss of plant food goes on under cropping, if restitution be not adequately made with farm manure, artificial fertilisers may be required.

The effective and economical use of barn-yard manure is without doubt one of the most important problems of modern agriculture for on this material the farmer's hopes of maintaining the fertility of his land, and thus providing for a succession of good crops, are mainly based. Experiments continued for twelve years at the Central Experimental Farm have shown that a given weight of manure taken fresh from the barn yard is equal in crop producing power to the same weight of rotted manure. It has also been shown by repeated tests that fresh manure loses during the process of rotting from 50 to 60 per cent of its weight. It is estimated that the farm manure produced in Canada amounts probably to about 100 million tons a year. The financial loss involved in the wasteful handling of such a vast amount of valuable plant food shows the great importance of this subject.

When we consider that all the food taken from the soil by plants must be furnished to the roots in aqueous solution, the necessity of a sufficient supply of water is apparent. The quantity of water held in a soil at any given period is not wholly dependent on recent ranfall, and it is astonishing how much the proportion of moisture in a soil can be influenced by cultivation. Soil when allowed to remain for a time undisturbed, gradually settles into what is known as a capillary condition, through which water in the soil below is brought readily to the surface, where it evaporates. If soil is allowed to remain long in this condition, it will bring water thus from considerable depths. The ploughing of a soil breaks up this capillary structure, and subsequent cultivation pulverises it and reduces it to a good condition of tilth. After this the mere scratching of the soil to the depth of an inch or two leaves the surface in a porous condition which acts like a mulch and prevents much of the moisture below from escaping. Thus, by judicious cultivation, the proportion of moisture in a soil can be regulated and loss controlled. In this way crops can often be produced on semi-arid land, too dry to give favourable results with ordinary treatment.

A few moments must now be given to the latter part of my subject, referring to the great progress made in agriculture in Canada during the past few years.

Twenty-three years ago farming in Canada was in a very depressed condition and in 1884 the House of Commons appointed a Select Committee to enquire into this subject and to suggest the best means of developing and encouraging the agricultural interests of this country. Careful investigation led to the conclusion that the general lack of success was not due to any fault of the soil or climate, nor to want of industry among the farmers, but to defective farming from want of skill and knowledge in all branches of this work, and up to this time, no provision had been made by the Government to remedy this. There is probably no industry engaging the attention of mankind that requires more skill and general information to conduct successfully than farming. Competition in food products is keen throughout the civilized world, and the farmer must turn to practical account every advantage within his reach to improve the quality of his products and to lessen the cost of their production if he is to improve his position.

The Committee recommended that the Government should establish experimental farms, where experiments might be carried on in all branches of agriculture and horticulture and that the results of this work should be published from time to time and distributed freely among the farmers of the Dominion.

The recommendations of the Committee were favourably received and early in 1886 an act was passed authorizing the Government to establish a central experimental farm and four branch farms. The central farm was to be located near Ottawa and the branch farms in different parts of the Dominion, one in the Maritime Provinces, one in Manitoba, one in the Northwest Territories and one in British Columbia.

In choosing these sites an effort was made to have them fairly representative in soil and climate of the larger settled areas in the provinces or territories in which they were placed. In the arrangement of the work such experiments as were most likely to be beneficial to the larger number of settlers were in each case among the first to engage the attention of the officers in charge.

Twenty years have passed since this work was begun and during that time agriculture in Canada has made unprecedented advancement. Investigations and experimental researches have been conducted in almost every line bearing on agriculture and horticulture and a multitude of important facts have been accumulated and given to farmers throughout the Dominion in reports and bulletins. The principles which underlie successful crop-growing have been frequently dealt with and demonstrated. The importance of maintaining the fertility of the land, adopting a judicious rotation of crops, following the best methods of preparing the land, early sowing, choosing the best and most productive varieties and the selection of plump and well-matured seed, all these have been shown to be essential to success.

Through the experimenal farms early ripening sorts of grain have been brought from many countries wherever they could be found. While none of those tried have been found equal in quality to the best sorts already cultivated here, the new importations have given early ripening strains, which, by skilful crossing and selecting, have already produced excellent results. Several of the newer varieties of wheat ripen from two to three weeks earlier than some of the well known sorts in cultivation, thus opening up a prospect of considerably extending the wheat area in the Canadian Northwest. Distinct gains have also been made by crossing and selection in other classes of cereals. Varieties of grasses, suited to the needs and conditions prevailing in the Northwest have been experimented with and distributed for test, whereby dairying and stock raising are now becoming easier to conduct and more remunerative. New apples also have been produced by crossing very hardy forms of Siberian crab apples with varieties of apples grown in Eastern Canada. These cross-bred sorts have proved quite hardy at several hundred different points at varying altitudes, and are succeeding in those parts of the Northwest country where ordinary apples are too tender to be successfully grown.

Other lines of original research, chemical, botanical and entomological, have also been followed with great assiduity, while the other branches of agricultural and horticultural work have been carried on with similar enthusiasm, and special bulletins on many important subjects have been published and widely distributed.

The backward condition of agriculture in Canada, which was so pronounced twenty years ago, has given place to one of constant progress and advancement, and, instead of a lack of skill and knowledge among the farmers of this country, I think it may now be safely said that Canadian farmers, on an average, are as well informed and more generally progressive than those of any other country in the world.

The Experimental Farms have been one of the important factors in the educative work of this country and the Government is now wisely adding to the opportunity of Canadian farmers to gain knowledge by increasing the number of these institutions. Two experimental stations have recently been established in Alberta, one in the southern part of the province at Lethbridge, to study the various problems connected with irrigation and dry farming, and one further north at Lacombe to carry on experiments in general farming suitable for that district. Experiments are also in progress under Government direction in the Peace River country and the Yukon. It is expected that other sub-stations will shortly be established on Prince Edward Island, Vancouver Island and in northern Saskatchewan. These will no doubt be followed by others so that eventually these experimental institutions will be sufficiently numerous to meet the needs of our various climates.

The reputation of Canada as an advanced agricultural country stands high, and other nations are earnestly interesting themselves in the fine agricultural products for which Canada is now noted. When the National Miller's Association of Great Britain began their efforts to improve the quality of the wheat grown in the Mother Country, application was made for the best wheats obtainable here and although varieties were obtained by them from many other countries, none have yet been found superior to the best of those sent from Canada. Many other lands have also sought for samples of the agricultural products of this country for trial. Among the British Colonies many different sorts have been sent to Australia, South Africa and Newfoundland. India has applied for some of the best products for test in that country especially in the higher altitudes in the mountain districts. Requests have recently come from Thibet for food materials likely to be grown with success in the high plains of that country at altitudes ranging from 12,000 to 16,000 feet. In response to requests from the Russian Department of Agriculture many varieties of wheat, barley and maize have been supplied which are being tested in different parts of that Empire. Even from Egypt the great granary of early times requests for Canadian grain have been received and the varieties sent are now being tested at Khartoum and along the Nile. To Japan also many different sorts have been forwarded for trial, and quite recently a number of different varieties have been sent for test in that part of the Saghalien Islands which reverted to Japan as a result of the late war. Similar requests have also been recently responded to from Italy and from Mexico. Canada has won an enviable reputation as a country of vast agricultural resources, and the published records of her progress have many interested readers in all countries where intelligent agriculture is practised. Immigrants are flocking to our shores in large and increasing numbers and millions of acres of virgin lands are being brought under crop. The mass of surplus food products available for export, shows every year a marked increase while as yet the area of land under cultivation is relatively small. What these exports will amount to in the near future, when the country becomes well settled, and the acreage of crop much larger, no one can accurately foretell. Enough, however, is known to warrant the statement that Canada will shortly become one of the greatest food-exporting countries of the world.